

REMARKS

In response to the final Office Action of April 22, 2003, Applicant submits a Request for Continued Examination, together with this Response, to place the application in condition for allowance. Claims 1-17 and 29-49, which were previously withdrawn, are canceled without prejudice in order to expedite prosecution of this application. Applicant reserves the right to pursue these claims in future continuing applications. Reconsideration and allowance of all of the claims currently undergoing examination are requested in light of the following remarks and a declaration under Rule 132 of the inventor.

Allowed Claims

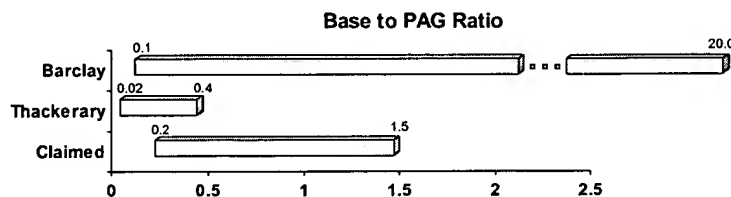
Applicant acknowledges with appreciation allowance of claims 19, 50, and 51.

Rejections Under 35 U.S.C. 103

The Office Action rejects claims 18, 20-24, and 52 as being obvious over the teachings of U.S. Patent No. 6,306,554 of Barclay. In addition, the Office Action rejects claims 18, 20, 21, 23, 24, and 52 as being obvious over Barclay in view of Thackeray.

Claim 18, as amended, recites a photoresist having a micron or submicron linewidth variation when exposed to radiation having a wavelength of about 248 nm or less. The photoresist includes a polycyclic copolymer, a photoacid generator and a base having a molar concentration ratio in a range of about 0.2 to 1.5 relative to the photoacid generator.

Neither Barclay nor Thackeray recognizes that utilizing a base to PAG molar ratio in a range of 0.2 to 1.5, recited in amended claim 18, in a photoresist composition provides unexpectedly enhanced line edge roughness when the resist composition is exposed to actinic radiation. As the following chart indicates



the claimed range of 0.2 to 1.5 is not coextensive with the range of 0.1 to 20, or 0.02 to 0.4, purported by the examiner to be inferred from Barclay and Thackeray, respectively, for the base to PAG molar ratio. In fact, the range of 0.2 to 1.5 overlaps only a small portion of the broad range associated with Barclay, and only about a half of the range associated with Thackeray. As described in the attached affidavit of the inventor, resist compositions having base to PAG molar ratios outside the claimed range of 0.2 to 1.5 either exhibit considerably degraded line edge roughness, or worse, they fail to function as viable positive resists. Hence, molar ratios in a large portion of the ranges associated with Barclay and Thackeray are simply not suitable for obtaining enhanced line edge roughness.

In fact, neither Barclay nor Thackeray is concerned with minimizing line edge roughness of photoresist compositions, and neither reference teaches adjusting the molar ratio of base to PAG in such compositions to be in a range of about 0.2 to 1.5, recited in amended claim 18, to obtain enhanced line edge roughness. Hence, claim 18 distinguishes patentably over both Barclay and Thackeray because it recites a range of base to PAG molar ratios that result in obtaining unexpectedly enhanced results. The cited Barclay and Thackeray patents will be described in more detail below.

Barclay is understood to describe photoresist compositions having polymer resins that contain heterocyclic rings. The photoresist compositions of Barclay, in addition to a resin binder, can include a photoacid generator and a base additive. Barclay generally recites that the added base is used in relatively "small amounts, e.g., about 0.03 to 5 percent by weight relative to the total solids." In Example 7, Barclay recites exemplary concentration values of the photoacid generator and the base, which translate to a molar ratio of 0.1 for the base relative to the photoacid generator, which is significantly lower than values taught by the claimed invention. The Examiner, however, states that because Barclay utilizes the lower point in its recited range for base concentration in Example 7, one of ordinary skill in the art can fix the PAG concentration at the value given in Example 7 and vary the base concentration over the recited range of about 0.03 to 0.5 to obtain a molar ratio of 0.1 to 20.

As an initial matter, Barclay is not concerned with the ratio of base to PAG in its resist formulations. It is only with the benefit of Applicant's invention that the Examiner suggests

fixing the PAG's concentration at the value provided in Example 7, and varying the base concentration to obtain a base to PAG ratio of 0.1 to 20.

Further, even if one agrees with the Examiner that Barclay can be viewed as providing a broad teaching that the molar ratio of base to PAG should be in a range of about 0.1 to 20, claim 1 is nonetheless patentable over Barclay because the narrower range of 0.2 to 1.5, recited in claim 1, provides unexpected results. In other words, this range of molar ratio of base to PAG results in much lower line edge roughness (LER) of the photoresist composition when exposed to radiation. In particular, Examples 1, 4, 5, and 6 provided in Applicant's specification indicate that a base to PAG molar ratio that is less than 0.2 results in an inferior LER than molar ratios above 0.2. For example, an LER of 8.2 nm was observed for a resist composition having a base to PAG molar ratio of 0.16 whereas a resist composition having a base to PAG molar ratio of 0.32 exhibited an LER of 4.1 nm (See Example 1 in Applicant's specification).

Further, the attached affidavit of Applicant, in which experimental results regarding resists having compositions with base to PAG molar ratios that are significantly higher than 1.5 are presented, indicates that such resist compositions are not suitable for use as positive resists. For example, the tested resists having a base to PAG molar ratio of 2, 5, and 10 failed to image. In other words, in these resists, some resist film remained on the wafer in the exposed areas even after exposure to a very high radiation dose of 50 mJ/cm². Moreover, the compositions having base to PAG molar ratios of 15 and 20 failed to exhibit any substantial difference in solubility between the exposed and unexposed areas upon immersion of the wafer in a basic solution, subsequent to exposure of the resist film disposed on the wafer to actinic radiation. In other words, in these resists, both the exposed and unexposed portions were removed upon treatment with a basic solution. Hence, these compositions can not be utilized as positive resists for generating patterned masks.

Thus, the range of about 0.2 to 1.5 for the molar concentration ratio of base to PAG in photoresist compositions recited in amended claim 18 provides enhanced efficacy in minimizing line edge roughness of the compositions when exposed to actinic radiation while maintaining their ability to function as positive resists. Barclay, however, does not recognize that such a

range of base to PAG molar ratios provides enhanced properties. Accordingly, claim 18, and claim 52 that depends on claim 18, are patentable over Barclay.

Similar to claim 18, amended claim 20 recites, among other features, that the molar concentration ratio of the base to the photoacid generator lies in a range of about 0.2 to 1.5. Hence, the arguments presented above apply with equal force to establish that claim 20, and claims 21-24 that depend on claim 20, are also patentable.

In paragraph 3, the Office Action rejects claims 18, 20, 21, 23, 24, and 52 as being unpatentable over Barclay in view of U.S. Patent No. 5,879,856 of Thackeray.

As discussed above, Barclay fails to teach or suggest the claimed invention. As discussed below, Thackeray does not bridge the gap in Barclay's teachings to render the claimed invention obvious.

Thackeray is directed to photoresist compositions that include a resin binder having photoacid labile groups, a photoacid generator, and a photospeed control agent, which can be a strong base. Thackeray is primarily concerned with adjusting photospeed of its resist compositions by controlling the amount of the photospeed control agent present therein. Thackeray recites that the "photospeed control agent can be employed in relatively small amounts, e.g., about 1% to 20% by weight relative to the PAG."

Even if one agrees with the Examiner's statement that the broadest teachings of Thackeray regarding the concentration of the photospeed agent results in a photospeed to PAG molar concentration ratio of 0.0212 to 0.42, the claimed range of 0.2 to 1.5, which overlaps only a portion of this range, provides enhanced line edge roughness. In particular, Thackeray does not recognize that a sub-set of the range of 0.0212 to 0.42, namely, a range of 0.2 to 0.42, for the base to PAG molar ratio can result in photoresist compositions exhibiting much enhanced line edge roughness. Neither did Thackeray realize that the range of base to PAG molar ratio can be extended from 0.4 to 1.5 while maintaining the enhanced line edge roughness of the photoresist compositions. Hence, Thackeray fails to render the claimed invention obvious.

Independent claim 20 recites a photoresist having micron or submicron linewidth variation when exposed to radiation having a wavelength of about 248 nm or less. The claimed photoresist includes a cycloolefin based polymer or copolymer, a photoacid generator and a base having a molar concentration in a range of *about 0.2 to 1.5* relative to the photoacid generator. The arguments presented in connection with claim 18 apply with equal force to establish that claim 20 is also patentable over the combined teachings of Barclay and Thackeray. Further, claims 21, 23 and 24 depend on claim 20, and hence are patentable as well.

Claim 52 depends on claim 18, and further defines the molar concentration ratio of the base relative to the photoacid generator to be in a range of about 0.5 to 1.5. As discussed above, Barclay fails to suggest such a range for the molar concentration ratio of the base relative to the photoacid generator, and the broadest teachings of Thackeray, purported to be in a range of 0.0212 to 0.42 by the Examiner, falls outside this range. Hence, claim 52 distinguishes patentably over the combined teachings of Barclay and Thackeray.

In Paragraph 4, the Office Action rejects claims 25-28 as being unpatentable over Barclay in view of Published Application No. WO 00/67072 of Feiring et al.

Claim 25 describes a photoresist having micron or submicron linewidth variation when exposed to a wavelength of about 248 nm or less that includes a polymer or a copolymer containing fluorinated alcohol substituted polycyclic ethylinically unsaturated monomeric unit, a photoacid generator and a base having a molar concentration in a range of about 0.2 to 1.5 relative to the photoacid generator. As discussed above, Barclay does not suggest such a molar concentration ratio of base to photoacid generator. Further Feiring, which relates to fluorine containing polymer compositions having UV transparency, does not teach the range of base to PAG ratio recited in claim 25. Hence, claim 25 is patentable over the cited references. Further, claims 26, 27, and 28 depend on claim 25, and are patentable as well.

In Paragraph 5, the Office Action rejects claims 25, 26, and 28 as being obvious in view of the combined teachings of Barclay, Thackeray, and Feiring.

The arguments presented above apply to establish that these claims distinguish over the combined teachings of the cited references. In particular, none of the references recognizes that range of the base to PAG molar ratio recited in these claims is particularly efficacious for minimizing line edge roughness of photoresist compositions when exposed to actinic radiation.

Accordingly, claims 25, 26, and 28 distinguish patentably over the cited references.

New Claims

New claims 53-55 depend on allowed claim 19, and hence are in condition for allowance.

Support for claim 56-59 can be found throughout the specification, for example, on page 3, lines 15-22, page 5, lines 15-25. Thus, no new matter is added. The arguments presented above apply with equal force to establish that claims 56-59 distinguish patentably over the cited art.

CONCLUSION

In view of the above amendments and remarks, Applicant respectfully requests reconsideration and allowance of the application. The Examiner is invited to call the undersigned at (617-439-2514) if there are any remaining issues.

Dated: Oct. 22, 2003

Respectfully submitted,

By 

Reza Mollaaghababa

Registration No.: 43,810

NUTTER MCCLENNEN & FISH LLP

World Trade Center West

155 Seaport Boulevard

Boston, Massachusetts 02210-2604

(617) 439-2000

(617) 310-9000 (Fax)

Attorneys for Applicant